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TECHNICAL NOTE

MRL-TN-456

MODIFICATION OF THE TECHNIQUE FOR THE MECHANICAL POLISHING OF CAST TNT COMPOSITIONS

M.A. Parry

Approved for Public Release

SEPTEMBER, 1981

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ABSTRACT

Previous work at MRL established a technique for the mechanical polishing of specimens of cast TNT compositions. Due to the unavailability of materials used in the technique, modifications were made which maintained the high quality finish observed previously.

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16. ABSTRACT (if this is security classified, the announcement of this report will be similarly classified):

Previous work at MRL established a technique for the mechanical polishing of specimens of cast TNT compositions. Due to the unavailability of materials used in the technique, modifications were made which maintained the high quality finish observed previously.

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MODIFICATION OF THE TECHNIQUE FOR THE MECHANICAL POLISHING OF CAST TNT COMPOSITIONS

1. INTRODUCTION

Previous work [1-3] at MRL established a technique for the mechanical polishing of RDX/TNT. The most satisfactory method for revealing the microstructure of the explosive for optical microscopy was to prepare the specimen by a three-stage mechanical polishing sequence, namely;

(a) primary polishing with wet 600 # silicon carbide paper,

(b) intermediate polishing by hand on nylon velvet using an aqueous paste of magnesium oxide, and

(c) finishing on a vibratory polisher.

A one to five second etch with bromoform showed up the grain orientation of the TNT matrix.

During a recent investigation of the effect of additives on the properties of TNT-based explosives there was a requirement for microstructural examination of the size and orientation of TNT grains in experimental casts [4]. Because of unavailability of polishing materials, changes to the polishing technique were required. This note describes these changes and illustrates that the modified technique maintains the high-quality finish obtained previously.

2. RESULTS AND DISCUSSION

2.1 *Primary Polishing*

The established technique used 600 # silicon carbide abrasive paper clamped to an inclined glass deck with a flow of water from a sprinkler for safety and to prevent clogging. The contaminated water was collected in a settling tank and filtered to remove explosive before disposal.

The work here used P1200 A paper [5]. 600 # paper was classified according to the American Standard Grading whereas P1200 A is the equivalent paper according to the Standard European Grading. A suffix A related to the type of backing. P1200 A has 50% of silicon carbide particles of 15.3 ± 1 µm and a narrower distribution of particles about the median than American Standard papers - this leads to a better finish at the primary polishing stage.

It was found that rubbing a steel block on the P1200 A paper prior to polishing and cleaning the paper regularly with acetone (and then flushing with water) during polishing gave a less scored finish. Finer grade papers with narrower distributions of silicon carbide are manufactured [5] and it is planned to test some of these.

The P1200 A paper is sufficient to remove all but the roughest of saw cuts (which require the coarser P600 A paper). The duration of the primary polish was generally 5-10 minutes.

2.2 *Intermediate Polishing*

The function of the intermediate stage is to cut away the damaged layer at and below the surface which formed during the primary polishing stage. The established technique used a 2 mm thick layer of aqueous paste of magnesium oxide on pure nylon velvet stretched over a glass plate. Hand polishing for about two minutes was considered adequate. Magnesium oxide ("calcined pond") from J. Preston Ltd., Sheffield, England, was recommended because it was free of magnesium carbonate which forms agglomerates which scratch the surface.

After extensive enquiries with local drapers and fabric importers/exporters it was found that nylon velvet had not been available commercially for 'about 5 years'. Therefore, a readily available velvet, pure cotton velvet, was purchased.

Enquiries after J. Preston Ltd. showed that this company was still in existence but the magnesium oxide was more expensive and less readily available than alternative local sources. BDH Chemicals (Australia) Pty. Ltd., Port Fairy, Victoria, sell a range of magnesium oxides. The cheapest and finest particle size grade was used - Magnesium Oxide (light) [6].

It was found that firm hand polishing for 2 minutes using an aqueous paste from BDH MgO on pure cotton velvet produced a surface with only light scoring. The velvet is wetted (distilled water) before stretching on the glass plate before the paste is applied as a layer of about 2 mm thick. This stage prepared the surface for the finishing stage.

2.3 Finishing and Etching

The established technique used a commercial vibratory polisher, again with a thin layer of magnesium oxide paste on nylon velvet. Alternatively, a thick layer of paste was used and the specimen "skidded" by hand over the paste surface. About ten minutes was adequate for finishing and the nylon velvet was cleaned to allow reuse.

It was found that using pure cotton velvet and paste from BDH MgO produced a high quality finish on the specimens. Polishing for 5 minutes was sufficient when polishing by hand. Specimens were etched for 1-5 s depending on the etching which occurred during polishing. After immersion in bromoform the specimens were flushed with water, dried lightly, and the microstructure was then examined with a Leitz microscope by reflected light.

2.4 Results of the Polishing Technique

Figures 1 to 6 are photomicrographs of polished surfaces of a number of cast TNT compositions. All casts (except the one in Figure 5) were etched with bromoform to highlight grain boundaries.

Figures 1 and 2 show the fine grain structure of the chilled layer region and large aligned structure of a TNT cast. The result of grain modification is seen in the "poured-cloudy" TNT cast (Figure 3). The TNT grains in the bulk of this cast are much finer than those shown in Figure 2, and have random orientations in comparison to the direction of heat flow during solidification.

Figure 4 shows the equant, rounded, RDX crystals and the underlying aligned TNT structure of Composition B (60 RDX/40 TNT/1 BW). Figure 6 shows these features at an increased magnification. The RDX used in the fabrication of this cast was recrystallized from cyclohexanone. Figure 5 shows the smaller particle size of boiled and milled RDX used to fabricate an earlier Composition B cast (55 RDX/45 TNT/1 BW). Note the high percentage of very small RDX crystals (fines) which are known to adversely affect the viscosity of the molten RDX/TNT slurry [7].

3. CONCLUSIONS AND RECOMMENDATIONS

It was found that simple but imposed modifications of the established polishing technique of TNT based compositions did not degrade the quality of the finish. It is recommended that a three stage process still be used, namely;

(a) primary polishing with wet 'used' P1200 A silicon carbide paper for about 5-10 minutes, with regular cleaning of the paper,

(b) intermediate polishing by hand on pure cotton velvet using locally available magnesium oxide as an aqueous paste - firmly for about 2 minutes,

(c) finishing on a vibratory polisher using a thin layer of paste on cotton velvet, or 5 minutes of light 'skidding' by hand on about a 10 mm thick layer of the paste on cotton velvet.

A 1·5 s etch with bromoform is required to highlight the grain structure of TNT.

Finer, narrow distribution abrasive paper should be investigated as a replacement for the 'used' P1200 A paper.

4. ACKNOWLEDGEMENTS

The author is indebted to Mrs J. Gray for her careful and diligent assistance with the polishing.

5. REFERENCES

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2. Connick, W. and Thorpe, B.W. (1968). MRL (DSL) Tech Note 119.

3. Thorpe, B.W. and Connick, W. (1969). Explosivstoffe, 12, 257.

4. Parry, M.A. and Thorpe, B.W. (1981). MRL Report 812.

5. The paper used was manufactured by 3M Australia Pty. Ltd. although it is commonly available from a number of companies. 3M (USA) also manufactures ultra-fine grade papers (e.g. median particles of 3 μm, 9 μm, and 15 μm,with a narrower distribution of particle size than P1200 A.

6. Characteristics of BDH MgO light. Water soluble matter 1.0%, loss on ignition at 1000°C 3.0%, Lead 0.002%, Chloride 0.05%, Sulphate 1.0%, Arsenic 0.0001% and Iron 0.03%.

7. Eadie, J. and Milne, D.J. (1968). MRL (DSL) Tech Note 115.

← DIRECTION OF HEAT FLOW DURING SOLIDIFICATION

FIG. 1 - Polished surface of chilled layer region of TNT cast.

FIG. 2 - Polished surface of columnar zone of TNT cast.

← DIRECTION OF HEAT FLOW DURING SOLIDIFICATION

FIG. 3 - Polished surface of "poured-cloudy" TNT cast showing smaller, randomly oriented TNT grains.

FIG. 4 - Polished surface of 60/40/1 Composition B showing large, rounded RDX crystals and underlying aligned TNT structure.

← DIRECTION OF HEAT FLOW DURING SOLIDIFICATION

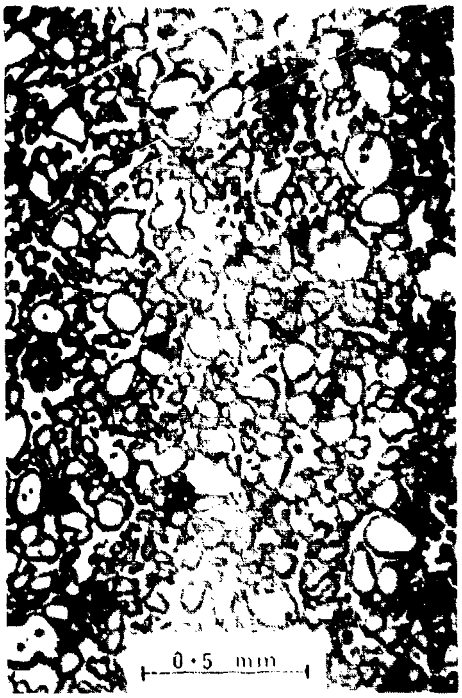

FIG. 5 - Polished (unetched) surface of 55/45/1 Composition B showing small particle size of RDX.

FIG. 6 - Polished surface of 60/40/1 Composition B.

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